October 4, 2018

Residential Rate Design and Electric Vehicles

Webinar for the Transportation and Climate Initiative States

The Regulatory Assistance Project (RAP)®

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www.raponline.org
Our Experts

Nancy Seidman

Jim Lazar
Questions?

Please hit the “raise hand” button to be unmuted …

... or type your question into the Questions pane.
1 Introduction
What does this rate design say?

$1.50  $2.25  $2.75
Price Can Influence When EVs Are Charged

Dallas/Ft Worth (standard rates)

San Diego (time-of-use rates)

Copied from: M.J. Bradley, 2017
Outline

• Beneficial Electrification and Electric Vehicles
• Smart Rate Design – General Principles, Terms
• Residential Rate Design Examples, Electric Vehicle Considerations
• Multi-family Residential Charging and Non-Residential Issues Identification
• Fast Charging and Medium, Heavy-duty Vehicle Issues
• Discussion
What makes electrification beneficial?

Three Criteria: Achieve at Least One Without Adversely Impacting the Others

1. Saves Customers Money Long-Term; New Services
2. Reduces Environmental Impacts
3. Enables Better Grid Management
The Grid Is Getting Cleaner

PJM System Data
Understand the Emissions Effects of Changes in Load
<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>2015-2050</td>
</tr>
<tr>
<td>Water Heater</td>
<td>2015-2050</td>
</tr>
<tr>
<td>Space Heater</td>
<td>2015-2050</td>
</tr>
<tr>
<td>Light-Duty Vehicle</td>
<td>2015-2050</td>
</tr>
<tr>
<td>Heavy-Duty Vehicle</td>
<td>2015-2050</td>
</tr>
<tr>
<td>Industrial Boiler</td>
<td>2015-2050</td>
</tr>
<tr>
<td>Power Plant</td>
<td>2015-2050</td>
</tr>
<tr>
<td>Residential Building</td>
<td>2015-2050</td>
</tr>
</tbody>
</table>

Measure Life Matters
TCI States - Transportation is the Biggest Portion of Emissions

Source: Georgetown Climate Center based on U.S. Energy Information Administration, 2015 State energy-related carbon dioxide emissions by sector
“Fueling” EVs

100,000 EVs =

116 MW of wind (37% capacity factor)

52 MW of natural gas (80% capacity factor)

154 MW of solar (27% capacity factor)
2 What’s special about EVs?
Electric Vehicles Are A Lot Like Water Heaters
Really!

Electric Vehicle
- 3.3 – 6.6 kW
- 2,000 – 4,000 kWh/year
- Morning and early evening peaking if uncontrolled
- Batteries hold a full day’s supply (usually)

Water Heater
- 4.4 – 5.5 kW
- 2,000 – 4,000 kWh/year
- Morning and early evening peaking if uncontrolled
- Tank holds a full day’s supply (usually)
Three “Levels” of EV Charging

Level 1: Standard household current (120 Volts)
   1.5 kW   Adds about 4 miles range per hour

Level 2: High Capacity residential circuit (240 Volts)
   6.6 kW   Adds about 20 miles range per hour

Level 3: Fast commercial chargers in public areas with very large electricity connection:
   Up to 350 kW  Adds up to 200 miles in 15 minutes

Not Residential
EV Charging Opportunity

- 1,000 miles/month @ 25 mph average = 40 hours
- Driven: 40 hours/month
- Charging: 40 hours/month
- Parked: 680 hours/month

**Challenge:** Find 40 low-cost, low emission hours out of 680 hours that vehicle is parked each month. Put a smart charging station there.
3 Rate Design Principles
Key Terms for Residential Rate Design:

- **Customer Charge**: Fixed monthly fee to access utility service

- **Energy Charge**: Price per kilowatt-hour of consumption
4 Rate Design Examples
Types of Residential Rates

- Flat Rate
- Seasonal Rate
- Inclining Block Rate
- Time-of-Use Rate
- Combined Inclining Block / TOU Rate
- Critical Peak Pricing / Peak-Time Time Rebates
## Flat Rate

### Indiana–Michigan Power (Indiana)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Charge</td>
<td>$7.30/month</td>
</tr>
<tr>
<td>Energy Charge</td>
<td>$0.08634/kWh</td>
</tr>
</tbody>
</table>

Regulatory Assistance Project (RAP)®
# Unbundled Flat Rate (Typical in Restructured Regions)

<table>
<thead>
<tr>
<th>Northwestern Utilities (Montana)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Charge</td>
<td>$5.25/month</td>
</tr>
<tr>
<td>Delivery Charge</td>
<td>$0.0285/kWh</td>
</tr>
<tr>
<td>Power Charge</td>
<td>$0.0645/kWh</td>
</tr>
</tbody>
</table>
## Flat Rate/Seasonal

### Xcel Energy (Minnesota)

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Charge</td>
<td>$8.00/month</td>
</tr>
<tr>
<td>Summer Energy</td>
<td>$0.0867/kWh</td>
</tr>
<tr>
<td>Winter Energy</td>
<td>$0.0739/kWh</td>
</tr>
</tbody>
</table>

### Newfoundland Power

<table>
<thead>
<tr>
<th>Season</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>$0.0965/kWh</td>
</tr>
<tr>
<td>Winter</td>
<td>$0.1190/kWh</td>
</tr>
</tbody>
</table>
Most Common Residential Rate Design: Inclining Block

Goals include:

- Allocate low-cost resources
- Encourage conservation
- Provide essential needs at affordable cost
- Recognizes lower cost of apartment service
# Residential Inclining Block Rate

## City of Palo Alto (California)

<table>
<thead>
<tr>
<th>Customer Charge</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>First 300 kWh</td>
<td>$0.096/kWh</td>
</tr>
<tr>
<td>Next 300 kWh</td>
<td>$0.130/kWh</td>
</tr>
<tr>
<td>Over 600 kWh</td>
<td>$0.174/kWh</td>
</tr>
</tbody>
</table>
Rate Designs That Encourage Off-Peak Charging of EVs

- Well-designed Time of Use Prices (TOU)
- Critical Peak Price (CPP)
- Peak Time Rebates
- Transparent Real Time Prices (RTP)
Example TOU Rate:

<table>
<thead>
<tr>
<th>City of Tallahassee, Florida</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customer Charge</strong></td>
</tr>
<tr>
<td><strong>Off-Peak</strong></td>
</tr>
<tr>
<td><strong>On-Peak</strong></td>
</tr>
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TOU and Inclining Block Rates Have Very Different Impacts on EVs

<table>
<thead>
<tr>
<th>Inclining Block Rate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Charge</td>
<td>$5.00</td>
</tr>
<tr>
<td>First 500 kWh</td>
<td>$0.08</td>
</tr>
<tr>
<td>Additional kWh</td>
<td>$0.15</td>
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<table>
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- TOU rate provides an incentive to charge off-peak
- EV users are likely to be larger-than-average users
- Inclining block rate will mean charging at the higher block rate(s)
# Fixed-Period TOU Rates With Inclining Block Design

<table>
<thead>
<tr>
<th>Ft. Collins, Colorado</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customer Charge</strong></td>
<td>$6.16/month</td>
</tr>
<tr>
<td><strong>Off-Peak</strong></td>
<td>$0.066/kWh</td>
</tr>
<tr>
<td><strong>On-Peak</strong></td>
<td>$0.235/kWh</td>
</tr>
<tr>
<td>Tier Charge (surcharge on all usage over 700 kWh)</td>
<td>+$0.018/kWh</td>
</tr>
</tbody>
</table>
## Critical Peak Residential Rate Design

### Cost to Connect to the Grid

| Service             | Rate ($)  
|---------------------|-----------
| Billing $/mo        | $4.00     |
| Line Transformer $/kVA/Mo | $1.00      |

### Energy Consumption

| Peak Level            | Rate ($)  
|-----------------------|-----------
| Off-Peak $/kWh        | $0.07     |
| Mid-Peak $/kWh        | $0.09     |
| On-Peak $/kWh         | $0.14     |
| Critical Peak $/kWh   | $0.74     |
Peak-Time Rebates: The Maryland Solution

Customer Charge: $7.90/month
Distribution Charge: $.0315/kWh
Default Energy: $.0766/kWh
Critical Peak Rewards: -$1.25/kWh

1 PM to 7 PM on “Energy Savings Days”

https://youtu.be/cVCq7SIJnIQ
Residential Rate Design Summary

- Flat rates are typically cheaper than gasoline
- Customers will shift to lower-cost hours
- Low-emission hours and low-cost hours may be different periods
- Smart charging may be an alternative to smart rate design
Rate design should make the choices the customer makes to minimize their **own bill** consistent with the choices they would make to minimize **system costs**.
Load Diversity: An Important Concept in Rate Design
Diversity Between Classes
6 EV Considerations
Technology Can Help
Technology Can Help
7 Multi-Family and Workplace Charging Issues
EVs are a Realistic Car for Urban Families Today
But Where to Charge?
New Multifamily

- Code changes to require EV charging in assigned or shared parking spaces
- Role for Vendors

Multi-Family Charging Solutions

ChargePoint Smart EV Charging Solutions for Apartments and Condos
Existing Multifamily

- Much more challenging installation cost
- Requires shared spaces and chargers
- Role for Vendors
Curbside Charging

• Works well in lower-density applications
• Utility-provided or Vendor-provided
Workplace Charging

- Applicable to subset of customers
- Requires installation
- Commercial rate design issues
- Free, or vendor-provided options
8 Fast Charging
Fast Charging

- May be needed to enable the EV transformation
- Very High Capacity: 40 kW up to 350 kW
Fast Charging Costs and Pricing

- Commercial rate “demand charges” can make this prohibitive.
- Because they are used infrequently, the demand charge can drive the cost up to $1.50/kWh, or $15/gallon equivalent.
- Commercial rate design reform needed.
- Embed capacity costs in TOU energy prices, not demand charges.
9 Medium and Heavy Duty Vehicles
Medium and Heavy Duty Vehicles

• Require power levels similar to fast charging
• Therefore, similar location, timing issues and solutions
• Transit operator considerations – routes, demand charges
• Commitment of public transit fleets to conversions depends on a favorable rate design
Smart Rate Design

For a Smart Future

Authors
Jim Lazar and Wilson Gonzalez

July 2015
### Recommendations/Next Steps

- Rate Design is a powerful tool
- Find low cost periods to stimulate EVs
- Ensure low cost is also low emissions
- Encourage cross agency collaboration
- Evaluate and refine your programs
Resources from RAP

- Smart Rate Design for a Smart Future
- Beneficial Electrification: Ensuring Electrification in the Public Interest
- EV grid blog post – Calming Chicken Little
- Getting from here to there – regulatory considerations for transportation electrification
- Principles of Modern Rate Design
- Use Great Caution in the Design of Residential Demand Charges
About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org

Contact us at:
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nseidman@raponline.org
Smart Charging BMW-Style

Figure 6: BMW i ChargeForward Smart Phone App

Interface of the BMW i ChargeForward smartphone app
Keep It Simple in the Car

Smart Charge Controller

- **Economy Charge**
  - Full by 7 AM
  - $1.50

- **Urgent Charge**
  - Current Rate: $6.00

- **Custom Charge**
  - Enter Details
Green Power Subscription

Smart Charge Controller

- **GREEN Power Only**
  - 80% by 7 AM $2.00

- **Urgent Charge**
  - Current Rate: $6.00

- **Custom Charge**
  - Enter Details